論　文

Scale of anthropo-eco-geographical studies on the dry savanna of the Sahel: A brief overview

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1　Introduction

Dry savanna in the fringing zones of the Sahara, the Sahel in particular, has been undergoing year-by-year and interannual climatic anomalies, particularly droughts and erratic rainfall, for the last several decades. The anomalies, together with other changing aspects of the atmosphere-land interface such as invasions of migratory grasshoppers, rapid savannization and/or steppization processes, and land degradation induced by accelerated soil erosion and sand drift, have exerted remarkable influences on the geo-ecosystems, and have repeatedly threatened human habitations. The changing environments thus necessitate land management strategies concerning land use, agricultural production, and livestock raising.

The present study aims to briefly review and to conceptually discuss anthropo-eco-geographical studies on the drastically changing environments

and human responses in the Sahel, from the viewpoints of geographical scale and considering the studies conducted through a Japanese research initiative. The arguments mentioned below are chiefly derived from the author's commitment to an environmental-geographical study conducted in Republic of Niger, West Africa.

2 Studies on anthropo-eco-geographical dynamics in the Sahel

Highly variable or irregular rainfall over time and space characterizes the African dry savanna. Climatic events such as droughts and floods occur rather frequently. It is widely recognized that the African dry savanna areas continue to be very susceptible to accelerated wind and/or water erosion once triggered by denudation due to intensive land use, resulting in the emergence of devastated landscapes (Mainguet, 1995).

The vulnerability of land surface to erosion in this ecotone is also suggested by geo-chronological studies on paleo-environments of Africa. For example, fine sediments that were probably deposited in lakes or marsh-like environments are widely distributed in the dry savanna (Hori, 1987). Moreover, the African dry savanna environment has been displaying an extremely sensitive response to climatic change for many decades (Kadomura, 1994).

In general, studies on anthropo-eco-geographical dynamics explore examining the impacts of drastic environmental changes and human responses in the context of regional or local socio-economic, political and

cultural settings. The studies' aim, through analyses of inter-relationships among climatic event, landform, soil, hydrology, and vegetation, land use systems and indigenous folkloric knowledge of land resources, is the modeling of human responses to environmental changes. The approach is contextualized as the same as that of human responses to natural hazards (Fig. 1). The study framework of human responses to natural disasters is also discussed in Kates (1971).

Local people's livelihood is affected by environmental changes caused by climatic anomalies, ecological disturbances, and so on (natural event systems, in Fig. 1). Risk-avoiding strategy is considered to be interbedded in land-use systems and the management of living space (human use system, in Fig. 1). In historic times, the African dry savanna has witnessed large-scale migration of some ethnic groups in response to environmental changes, implying high vulnerability of human livelihood and susceptibility of land surfaces to stresses exerted by land use, over-use of natural resources, and so on.

With the above-mentioned background, the author of the present study has been involved in a collaborative research project, conducted in the Sahel (Hori, 1999, 2002). The first stage of the research was conducted, from 1995 to 1998 with the theme "Human response to climatic events in the dry savanna, Africa" (Hori, 1999). The second stage of the project, from 1998 to 2001, had the theme "Human response to drastic change of environments in the dry savanna, Africa" (Hori, 2002).

Multi- or inter-disciplinary approaches were taken into consideration when the project was organized. The framework of the research

was determined in view of the previously researched themes by the members, and through an interactive collaboration with the African counter-parts (Hori, 1987; Shinoda, 1989, 1990; Takaoka, 1994). The themes were mainly related to environmental changes, land degradation, subsistence systems, and human responses to drastic environmental changes in the African savanna.

Though being different to some extent, the studies conducted by the members stemmed from the same scope of anthropo-eco-geographical dynamics of the sub-Saharan dry savanna mentioned above. Study areas in three countries, Republic of Niger, northern parts of Cameroon, and northern parts of Kenya, are located in the same dry savanna zone at the global level, but are more or less different in local geo-ecological settings.

The studies of selected areas in each country aimed at methodologically establishing local geoecological maps and maps for local land use through field observations and measurements. In addition, an interpretation of aerial photographs and analyses of satellite images were integrated to comprehensively understand and extensively compare the selected local areas. An understanding of folkloric knowledge on land resource management and subsistence systems and perception of the environment was also taken into account for analytical reasoning and modeling.

3 Geographical scale of anthropo-eco-geographical dynamics in the Sahel

Studies on human responses properly require a proper understanding and evaluation of geoecosystems of relevant areas, that is an interrelation

among elements such as climate, topography, soil, plants, and animals, and comprehension of region-specific or locality-specific indigenous knowledge on land resource management, socio-economy, and culture (Fig. 1). In other words, the former involves the impacts of climatic changes or anomalies on land surface and the present state of land degradation, its evolution over time such as fluctuation of ground water level, historical geo-botanical dynamics, and so on. The latter refers to human responses, that is, land-use, natural resource management, indigenous knowledge, and perception of changing environments as underlying driving forces of the management and strategies.

The environmental changes and land degradation in the Sahel are best understood through studies combined at various levels conducted in different regions and in different time periods. In the research in

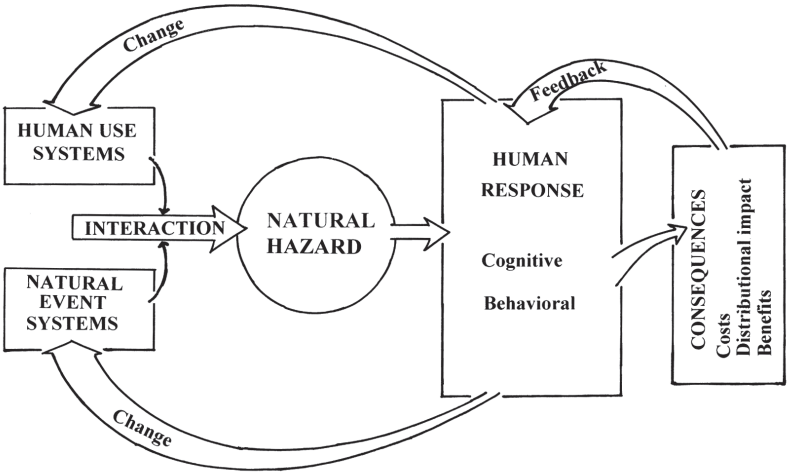

Fig. 1 Dynamics of response to natural hazards (simplified and partly modified after Sorensen and White (1980))

which the author of the present study was involved, for example, special attention was paid not only to local areas and community-household specific features in environmental changes such as droughts and desertification, geomorphic surface processes like soil erosion and drifting sands, hydrological processes like fluctuation of ground water level and soil moisture, but also to the subsequent human responses to such issues.

A number of climatological studies are being conducted, particularly those on the causal aspects of recent droughts. Shinoda (1989, 1990), for example, discussed rainfall variation in the African semi-arid regions over the past 100 years in the global context of atmospheric circulation. The climatic anomalies have made living conditions too difficult for inhabitation in the Sahel. The problem has been often examined as "desertification" at the global level (Kadomura, 1988; Kadomura *et al*., 1991).

Desertification and climatic drought problems have been frequently studied at the global level than those at the local level (Kadomura, 1988; Shinoda, 1989, 1990); less attention has been paid to the atmosphere-land surface interface and interaction at the local- and farmer-level. Reliable ground-truthed data of the state of environmental degradation are also very limited (for example, Biswass *et al*., 1987), although the global level narratives have attracted much wider concern than those at the local level.

Little research has been conducted from the viewpoint of human response to land degradation and environmental changes at the local level of the sub-Saharan dry savanna. Among the limited case studies, Ibrahim (1984), based on local studies, discusses human responses to

drastic climatic changes in the western Darfur of Republic of the Sudan. In Kenya, the University of Bern has conducted, in a similar global-local scope, a research project called the "Laikipia Project" since 1985 (Kohler, 1987). Shimada (1993) indicates that aridification of the lowlands of the River Niger is closely related to human activities. Nevertheless, a shortage of case studies and lack of data on human responses have led to highly simplified discussions, conclusions, and modeling.

Growing attention towards desertification and land degradation literature has been over simplified to the "fragility" of sub-Saharan dry and semi-dry savanna ecosystems. The word "fragility" implies destructibility in a final sense, or an abrupt and permanent degradation to a lower level of productivity. However, the idea of "fragility" of ecosystems, frequently encountered in literature, may not be an accurate representation of the semi-arid ecosystems (Mortimore, 1988). Dry land ecosystems may be far more resilient than is generally supposed (Johnson, 1979). The conventionally simplified concept of "desertification" and land degradation driven by human and livestock population growth is now challenged (Tiffen *et al*., 1994; Thomas and Middleton, 1994; Leach and Mearns, 1996). The same point of view is applicable to studies on human systems or human responses to drastic environmental changes (Mortimore, 1988), and may be accentuated in Japan or in studies conducted by the Japanese in the Sahel.

With the growing number of studies on rural development in the dry savanna of Africa, a number of recent studies have stressed upon the ecological wisdom of those belonging to ethnic cultures (Reenberg and Paarup-Laursen, 1997). The perspective was not highlighted much in earlier studies; traditional and cultural knowledge was often perceived as

a limiting element for "rational" development (Bendix, 1967). Although, one would expect that extreme climatic and hydrologic events, biological events, and socioeconomic events have had profound impacts on human life, settlement, natural resource management or use system, there is little conceptual or empirical exploration in sustainability literature (Goldman, 1995).

The brief overview mentioned above implies that local level studies, 10^{1} – 10^{-1}km of geographical scales (Fig. 2), are crucial for understanding

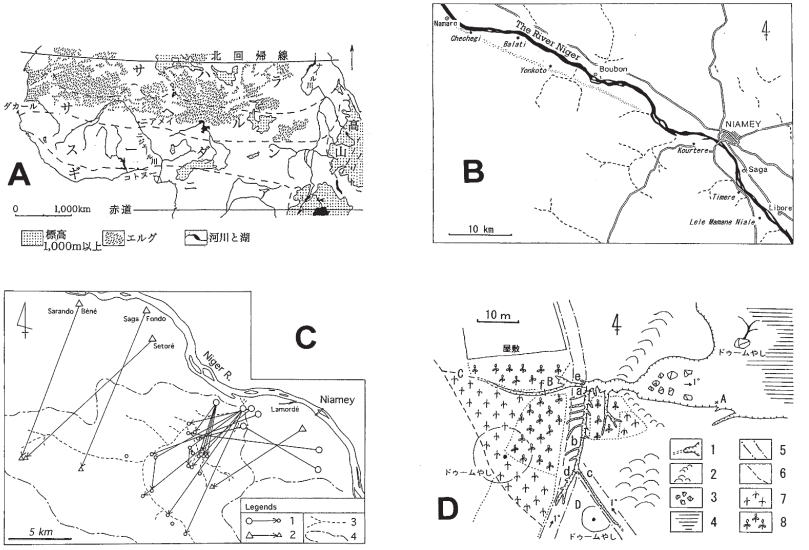

Fig. 2 Scales in space

A: $10^{3}-10^{2}$km: Sahara, Sahel, Sudan and Guinea Zones (Chinen, 2013b)

B: $10^{2}-10^{1}$km; Ravines (wadi) along the River Niger in the south-western Republic of Niger (Chinen, 2013a)

C: 10^{1} – 10^{0}km; Immigration of people of Kourtere Basin, south-western part of Republic of Niger (Chinen, 2002)

D: $10^{0}-10^{-1}$km; Land-use along a small gulley, Kourtere Village, south-western part of Republic of Niger (Chinen, 2011)

anthropo-eco-geographical dynamics in the Sahel, particularly human responses to environmental changes. The author of the present study argues that such a local level perspective should be based on a reliable ground-truthed dataset, and the ideas of "fragility," "resilience," "desertification," and land degradation should be discussed and evaluated in the light of the sustainable use of resources.

4 Concluding remarks

Even though a number of geographical studies have been conducted, few have focused on the aspect of human responses in the Sahel. The influences and human responses have been often regarded and studied from global scale viewpoints such as droughts, land degradation, "desertification," "fragility" of the ecosystems and human society. Shortage of local case studies and a lack of scientific data on human responses to the environmental changes in African dry savanna have engendered overly simplified discussions, conclusions, and modeling. The author argues that studies anchored in local traditional use of natural resources and local people's perception of a changing and transformed environment should be conducted with reference to "resilience" rather than "fragility." Studies based on ground-truthed data obtained from local sources, particularly from those in geographical scales of 10^{1} - 10^{-1} km, should be encouraged in the planning for the sustainable use of natural resources and land.

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